

**TITLE OF INVENTION:** "SELF LEAD FOIL WINDING CONFIGURATION FOR  
TRANSFORMERS AND INDUCTORS"

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SELF LEAD FOIL WINDING CONFIGURATION  
FOR TRANSFORMERS AND INDUCTORS

RELATED APPLICATION INFORMATION

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[0001] This is a continuation-in-part of Application No.  
09/707,661 filed November 7, 2000.

BACKGROUND OF THE INVENTION

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Field of the Invention

[0002] This invention is related in general to the field of  
inductors, in particular, to transformers, inductors, and coils  
which are mounted on printed circuit boards or the like.

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Description of the Related Art

[0003] Foil windings are becoming usual in a variety of  
electrical inductance applications. They are used in coils,  
inductors, and transformers of many varieties and applications.  
20 Their uses range from children's toys, to household appliances,  
to high technology and aerospace applications.

[0004] While the advantages of foil windings are acknowledged,  
there continues to be some problems associated with the use of

foil windings and similar winding materials such as parallel bonded magnet wire. One problem is connecting the foil winding to round wires. Round wires are typically used to conduct electric current to or from the foil winding. The cross section  
5 of the round wire is usually significantly less than the cross section of the foil. The result is local heating at the connection point, loss of energy, and higher failure rate.

[0005] Another problem is wrapping foil windings on a bobbin.  
10 Prior art bobbins (see figure 1) are useful when the windings comprise many layers of fine wire. However, as the width of the wire increases, the bobbin flanges cause the exits from early windings to interfere with later windings. This decreases the number of turns which the bobbin can accommodate on a single  
15 layer. This interference increases with wire size. The interference is even worse for parallel bonded magnet windings and even more serious for foil windings. For switching power supplies, increases in power levels and increases in switching frequency tend to require a decrease in the number of turns in a  
20 winding and an increase in the width of a winding turn. Under these conditions the interference caused by the exits from various windings becomes even more serious.

[0006] The prior art has attempted to solve these bobbin problems  
25 by cutting deep slots in the bobbin flanges to allow exits of

early windings, however, increases in the width of the windings has required ever wider slots in the flanges.

[0007] Clearly there exists the need for an improved coil

- 5 configuration which solves the problems associated with connecting a round wire to a foil winding, reduces interference from exits of windings, reduces energy loss, reduces local heating, and improves reliability.

## BRIEF SUMMARY OF THE INVENTION

[0008] The invention discloses a coil winding configuration for use in transformers, inductors, and the like. The invention is particularly useful with foil or parallel bonded magnet windings. End portions of a foil winding, having conductive opposite sides, are cut into flag shapes and folded to form a conductive stack of foil conductor. The stack configuration forms self leads of the foil winding and facilitates the winding's exits from the coil.

The self leads extend from the coil and are formed to reach to a printed circuit board (PCB). The self leads are strong enough serve as a mount for securing the coil to the PCB. The ends of the self leads are trimmed to fit through at least one hole in the PCB. After insertion, the layers of the self leads are bent in opposing directions to substantially block the hole, prevent extraction, and block the flow of solder through the hole. The self leads are then soldered to the board. A bobbin having discontinuous flanges facilitates the exits of the self leads from the coil.

[0009] The flag shaped pieces are formed by making longitudinal cuts in the ends of the foil conductor, having conductive opposite sides. One or more cuts are made depending on the desired shape of the resulting stack. The flag shaped pieces are folded to form a conductive stack which is at an angle to the

foil conductor. This process is performed for both ends of the foil conductor to form self leads for both exits from the coil. The dimensions of the conductive stack are adaptable to many applications. After the foil is wound on the bobbin, the  
5 conductive stacks extend from the coil and form the self leads.

[0010] The self leads preferably extend from opposing sides of the coil. The leads are bent as needed to reach a mounting board such as a PCB or the like. The leads are strong enough to  
10 function as stable mounts for the coil, transformer, or inductor. This eliminates that need for some other mounting fasteners thus reducing costs.

[0011] The leads are trimmed to fit through the receiving holes  
15 in the board. The preferred embodiment trims each lead into two legs which are inserted through two adjacent round holes in the board. After the leads are inserted into the holes, the layers are bent in opposing directions. This serves to secure the leads to the board and to block the holes to reduce the flow of solder  
20 through the holes during the flow solder process.

[0012] The new bobbin shape facilitates the exits of the self leads. A key feature are flanges of the bobbin which are discontinuous. Portions of the flanges are formed to be planar  
25 with the body of the bobbin. The preferred embodiment has four

flange portions which are planar with the bobbin body. The concept may be adapted to various bobbin and core shapes. This new bobbin shape is especially useful with parallel bonded magnet wire or with foil windings. Using the new bobbin, conductor  
5 exits do not interfere with the windings. This typically allows for one more turn per layer of single or parallel bonded magnet wire than would fit on a traditional bobbin. The flanges still protect the winding's insulation from the sharp corners of the core; but in their new position, they do not interfere with lead  
10 exits. Isolation between the primary and secondary windings are improved further by placing the primary and secondary lead exits on opposite sides of the core.

[0013] Therefore, an object of the invention is to provide an  
15 improved self lead winding configuration for coils, transformers, inductors, and the like.

[0014] A feature of the invention is a conductive stacked self lead which serves as a mount to a board (e.g., PCB).

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[0015] Another feature of the invention is a conductive stacked self lead inserted through a hole in a board and blocking the hole by bending layers of the self lead in opposing directions.

25 [0016] Another feature of the invention is a bobbin having a

discontinuous flange portion parallel with the body of the bobbin.

[0017] Advantages of the invention include reduced energy loss,  
5 eliminating local heating where a round lead previously connected  
to the foil winding, improved reliability, increased number of  
turns on a single layer of the bobbin (or reduced bobbin size),  
and isolation between primary and secondary windings. However,  
to achieve the benefit of reduced energy loss and to reduce local  
10 heating, it is necessary that foil end portions have conductive  
opposite sides.

[0018] Various other purposes and advantages of the invention  
will become clear from its description in the specification that  
15 follows and from the novel features particularly pointed out in  
the appended claims. Therefore, to the accomplishment of the  
objectives described above, this invention consists of the  
features hereinafter illustrated in the drawings, fully described  
in the detailed description of the preferred embodiment and  
20 particularly pointed out in the claims. However, such drawings  
and description disclose only one of the various ways in which  
the invention may be practiced.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Figure 1 illustrates a prior art bobbin.

- 5 [0020] Figures 2A, 2B, and 2C illustrate the steps to form  
conductive stacked self leads on a foil conductor.

[0021] Figures 3A and 3B illustrate attachment of conductive  
stacked self leads to a printed circuit board.

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[0022] Figure 3C shows the preferred embodiment of the invention  
mounting a transformer to a PCB.

- 15 [0023] Figure 4 is an exploded perspective view illustrating the  
bobbin of the invention.

[0024] Figure 5 is a perspective view of the invention as used  
for the secondary winding of a transformer.

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## DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

[0025] Figures 2A thru 2C illustrate forming the conductive  
5 stacked self leads. Figure 2A illustrates foil conductor 20,  
having conductive opposite sides, cut in the longitudinal  
direction of the end portion 20D of conductor 20 forming slot  
20A. Slot 20A divides conductor 20 into two flag shaped portions  
20B and 20C. Slot 20A is made sufficiently long so that the  
10 resulting conductive stacked self leads will reach the mounting  
board. Figure 2B illustrates the second step in forming the  
conductive stacked self leads. Flag shaped portion 20B is folded  
at an angle to foil conductor 20. Figure 2C illustrates flag  
shaped portion 20C folded at an angle to foil conductor 20 to  
15 overlap flag shaped portion 20B and forming a conductive stack.  
The end of flag shaped portion 20B is trimmed to match the length  
of flag shaped portion 20C. By utilizing a foil conductor having  
conductive opposite sides, the resulting conductive stack has a  
relatively large cross sectional area that facilitates the flow  
20 of electricity. This reduces local heating and associated energy  
loss.

[0026] Those of ordinary skill in the art recognize that several  
variations of this process are possible. Multiple slots 20A may  
25 be cut in foil conductor 20 to form multiple conductive flag

shaped portions. This will make more layers in the conductive stack; however, the stack will be narrower. Also, the slot or slots may be of zero width, that is, the slots may be a sheared separation with no removed material. The sheared separation  
5 performs that same function as a narrow slot.

[0027] The forming of the conductive stack is done to both ends of foil conductor 20; preferably prior to winding conductor 20 onto the bobbin. Foil conductor 20 is wound onto a bobbin such  
10 that the conductive stacks extend from the bobbin; thus forming the self leads 30. Once foil conductor 20 is wound on a bobbin it will also be referred to as a foil winding for purposes of this application. The self leads are strong enough to mount a transformer or similar device to a mounting board such as a PCB  
15 or the like. Mounting the self leads directly to the PCB eliminates the problems associated with connecting a round wire to the foil conductor 20. This increases reliability while aiding in the reduction of local heating and energy loss. Further, the self leads provide a stable mount for even a  
20 relatively heavy device (e.g., transformer); thus eliminating the need for some of the mounting means used in the prior art.

[0028] Figures 3A and 3B illustrate the attachment of the self leads to a PCB. The ends of self leads 30 are trimmed into two  
25 legs 31A and 31B (see Figure 3A). Legs 31 are trimmed to fit

through two round holes in a PCB. Legs 31 are inserted into holes and the layers of the legs 31 are bent in opposing directions to secure lead 30 to board 32. The bent legs 31 substantially block the holes in board 32 and prevent the flow of solder through the holes during the flow solder process.

[0029] Figure 3C shows the preferred embodiment mounting a transformer to a PCB. Self leads 30 extend from transformer 33. Leads 30 are bent to reach to board 32. Leads 30 are trimmed as shown in figure 3A and are attached to board 32 as shown in figure 3B. In this embodiment, the copper foil self leads are used only for the secondary winding. Primary windings 34 and auxiliary winding 35 extend from the opposite side of transformer 33. Primary windings 34 and auxiliary winding 35 are soldered to board 32 and complete the mounting of transformer 33 to board 32. Those skilled in the art understand that the invention may be used for either the secondary windings, primary windings, or both, depending on the application.

[0030] Figure 4 is an exploded perspective view illustrating the bobbin portion of the invention. Shown in figure 4 are bobbin 40 and two parts of transformer core 41. Bobbin 40 is different from a conventional bobbin (see Figure 1). The flanges 40A of bobbin 40 are discontinuous as compared to a conventional bobbin. Discontinuous flange portions 42 are shaped to be planar or

parallel with the adjacent body portion 40B. This new configuration is used to create four discontinuous flange portions 42A-42D on bobbin 42. This configurations permits winding exits which do not interfere with the windings. It also  
5 allows more windings on a layer or a smaller bobbin. The windings exit bobbin 40 via the discontinuous flange portions 42. An alternate embodiment envisions the elimination of discontinuous flange portions 42 which would create an aperture or gap in the flange 40.

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[0031] Figure 5 is a perspective view of the preferred embodiment of the invention used in a transformer. Shown in Figure 5 are transformer 33, core 41, windings 50, conductive stacked self leads 30, trimmed legs 31, discontinuous flange portions 42,  
15 primary windings 34, and auxiliary windings 35. Self leads 30 exit the windings 50 via the discontinuous flange portions 42. Self leads 30 are bend to reach the printed circuit board (not shown). Self leads 30 are shown with trimmed legs 31 for insertion into holes in the printed circuit board.

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[0032] Various changes in the details, steps and components that have been described may be made by those skilled in the art within the principles and scope of the invention herein illustrated and defined in the appended claims. For example,  
25 various kinds of coils, transformers, inductors, magnet wires,

and foil conductors could be used with equivalent results.  
Similarly, various physical embodiments are also envisioned.  
Thus, while the present invention has been shown and described  
herein in what is believed to be the most practical and preferred  
5 embodiment, it is recognized that departures can be made there-  
from within the scope of the invention, which is not to be  
limited to the details disclosed herein but is to be accorded the  
full scope of the claims so as to embrace any and all equivalent  
processes and products.